Ramtek 9400 Series Product Description
RM 9400/1X, 4X, 5X, 6X, 7X, 8X, 9X

A modular family of high resolution raster scan display systems for generating image, graphics and alphanumeric data in color, gray scale and black and white.

High Performance / High Resolution Graphics and Imaging

The Ramtek Model RM-9400 Display Generator is an off-the-shelf, commercial grade raster scan display system that drives industry compatible monochrome and color CRT monitors and large screen projectors. The system consists of a rack mount chassis, power supply and solid-state electronics that employ proven concepts and state-of-the-art microprocessor technology to solve a diverse range of graphic and image processing problems. The RM-9400 is capable of single or multi-channel operation, and may be configured as an output peripheral or as an on-line interactive display system.

While maintaining software compatibility, the RM-9400 brings increased resolution, performance and features to the popular RM-9000 product line. Maximum resolution has increased to 1024 scan lines of 1280 elements, and to 128 bits-per-element. Where feasible, screen refresh frequency has increased from 25/30 Hz (interlaced) to 50/60 Hz (repeat field) to insure a flicker-free display. Increased performance has been accomplished by upgrading the internal display processor, adding a special-purpose 16-bit bipolar microprocessor, and by reducing refresh memory access time. New features include context switching, extended display list storage, multiple high resolution fonts, coordinate transformation (translate, rotate and scale), decluttering, clipping, textured lines, filled polygons, 8 and 16-bit imaging modes, entity detection (pick), high-speed erase, pan and zoom.

As is true of conventional raster scan display systems, the RM-9400 first receives, decodes, scan converts and stores computer generated alphanumeric, graphic and/or image data into one or more dual-ported digital refresh memory systems; then scans these stored pictures at the television raster rate in order to produce the desired video signals. A variety of off-the-shelf video options allow the display to be tailored for particular applications.

The following features differentiate the 9400 from other raster scan display systems. The user may download subpictures and special symbol fonts into the RM-9400. The screen may be addressed in terms of a virtual picture coordinate system. Graphics are translated, rotated, scaled and clipped, and may be drawn in any of several line textures. Additional detail may be displayed as the picture is enlarged, or subtracted as it is reduced. Font, image and bit-per-element raster data are independently scaled and windowed. The entity detect feature identifies graphic procedures and instructions that draw objects pointed out by the operator. Stored pictures may be transformed by video lookup tables. Picture magnification and animation may be accomplished by standard pan and zoom hardware. Many other distinctive features are also available, i.e., blink, plot and bar chart generation, filled polygons, external synchronization, etc.

Design Flexibility

The multi-bus/multi-processor architecture and hardware/ software options allow the RM-9400 to be configured from proven, off-the-shelf "plug-in" modules. Where warranted by special requirements or large volume orders, the system may be further tailored to meet the specific requirements of the customer.

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Ramtek's Educational Department offers regularly scheduled hardware and software training at its headquarters facility in Sunnyvale, California. A world-wide network of Customer Service depot and repair stations is available to our customers. On-Site Service contracts are available.

System Description

Figure 1 diagrams the multi-bus architecture of the RM-9400 which optimizes throughput by enabling simultaneous operation of a number of different processing elements within the system. Each processing element performs specific functions. For example, coordinate transformation is performed by the Display Processor and Processor Expansion Module while vectors are drawn by the Memory Control Processor. This allows simultaneous setup of the next vector to occur as the last vector is being drawn into refresh memory. By overlapping these functions, vector throughput is increased. Similar distributed processing concepts are carried to virtually all aspects of display generation.

The following paragraphs briefly describe the various elements of the RM-9400 Display Generator:
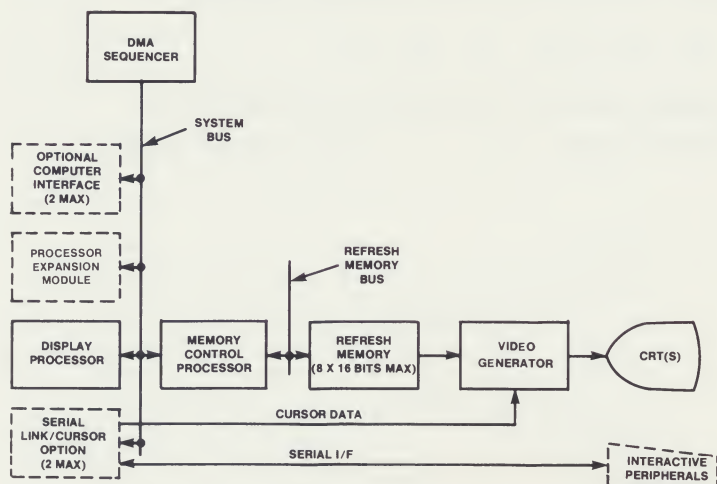
FIGURE 1. RM-9400 FUNCTIONAL BLOCK DIAGRAM

• Computer Interface (RM-9000-XX)

The Computer Interface provides a high-speed link between the host computer and the RM-9400 Display Generator. A general purpose interface (GPIF) is provided on the Display Processor. Two additional card slots are reserved for custom interfaces. Off-the-shelf interfaces are available for most minicomputers and some large mainframes. All interfaces are 16-bit parallel. Most incorporate or utilize direct memory access.

• DMA Sequencer

The TTL DMA Sequencer performs high-speed, non-processor transfers involving multiple devices on the System Bus; for example, between the Computer Interface and Display Processor or Memory Control Processor. The DMA Sequencer can involve as many as 14 ports and seven subloops.

• Display Processor

The Display Processor directly or indirectly controls each element of the display system. In addition, it decodes received instructions, stores subpictures (command lists) and fonts, performs coordinate transformations, and drives the Memory Control Processor. The Display Processor contains a Z80 microprocessor with 32K bytes each of EPROM and RAM, a GPIF interface, three serial ports, a timer, memory map, cycle-stealing DMA and interrupt control logic. The memory map accommodates up to 512K memory bytes, of which, 96K bytes are reserved for internal control software.

• Processor Expansion Module (RM-9400-PEM1/2/3/4)

The Processor Expansion Module adds a high-speed math unit, up to 32K bytes EPROM potential, and additional user RAM to the Display Processor. Memory expansion may be specified in 32K byte increments to a maximum of 128K bytes (where n = number of 32K byte increments).

• Memory Control Processor

The Memory Control Processor draws primitives (alphanumerics, graphics, images, etc.) into the refresh memory, and performs clipping, entity detection, pan and zoom. The MCP contains a special-purpose 16-bit bipolar microprocessor with dedicated ROM, RAM and support logic.

• Refresh Memory (RM-Y/X/Z)

The Refresh Memory consists of solid-state MOS RAM's that store the picture(s) in raster scan, dot matrix format. The memory is organized as one to eight groups of up to 16-bits each. Each 16-bit cell defines a single pixel on one or more CRT's. Table 1 lists the possible resolutions, aspect ratios, and refresh frequencies.

TABLE 1—RM-9400 RESOLUTION TABLE

Controller Model (RM-9400/nX)	Spatial Resolution		Aspect Ratio (X:Y)		Refresh Frequency (Frame Rate)
	Lines	Elements	Raster	Pixel	
RM-9400/1X	256	640	4:3	2:1	50/60Hz Repeat Field
RM-9400/4X	512	512	1:1(1)	1:1	50/60Hz Repeat Field
RM-9400/5X	512	640	4:3	1:1	50/60Hz Repeat Field
RM-9400/6X	512	1024	1:1(1)	2:1	50/60Hz Repeat Field
RM-9400/7X	512	1280	4:3	2:1	50/60Hz Repeat Field
RM-9400/8X	1024	1024	1:1(1)	1:1	25/30Hz Interlaced
RM-9400/9X	1024	1280	4:3	1:1	25/30Hz Interlaced

Note: (1) Active raster is centered within 4:3 CRT aspect ratio.

• Serial Link/Cursor Option (RM-9400-SLC2/4)

The Serial Link/Cursor option processes operator input from keyboards and graphic input devices, and generates two or four independent cursors that can be used to point to the face of the display without affecting the data in refresh memory. The RM-9400-SLC consists of a Z80 microprocessor with dedicated ROM and RAM, four or eight serial ports and two or four 32 x 32 programmable cursor generators. Support software is available for keyboards, joysticks, trackballs, light pens and graphic tablets.

• Video Generator (RM-9400-Vn)

The Video Generator transforms the stored pictures into industry compatible video signals that drive Ramtek or other commercially available high resolution CRT monitors, large screen projectors and hardcopy printers. All outputs are compatible with EIA Std. RS-170 or RS-343-A specifications for composite video.

The video generators process data on a pixel-by-pixel basis through PROM or RAM defined lookup tables that assign output color and/or intensity. Each pixel indexes the lookup table as it is scanned from the refresh memory. The contents of the addressed cell in the lookup table are then passed to the digital-to-analog converters (DAC) or video amplifiers that produce the output video signals.

Cursor and overlay mixing is performed either in the lookup table or at the DAC by clamping the output voltage to minimum or maximum scale. All video generators incorporate a blink frequency generator that allows selective blink.

There are three off-the-shelf video generators that satisfy most applications:

A. The Type I Video Generator (RM-9400-V1) is designed for general graphics applications. The RM-9400-V1 drives 12 two-bit (4-level) video outputs to 12 monochrome or four RGB color displays. In addition, the RM-9400-V1 provides hardware blink and mixes up to four independent cursors with any of the 12 output channels. Color, intensity, overlay and blink assignment are accomplished by PROM coding. Any of 64 colors or four intensities may be specified.
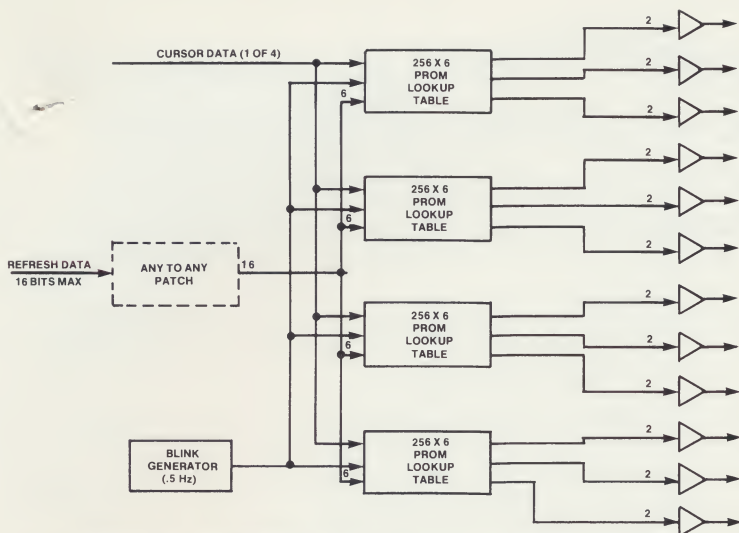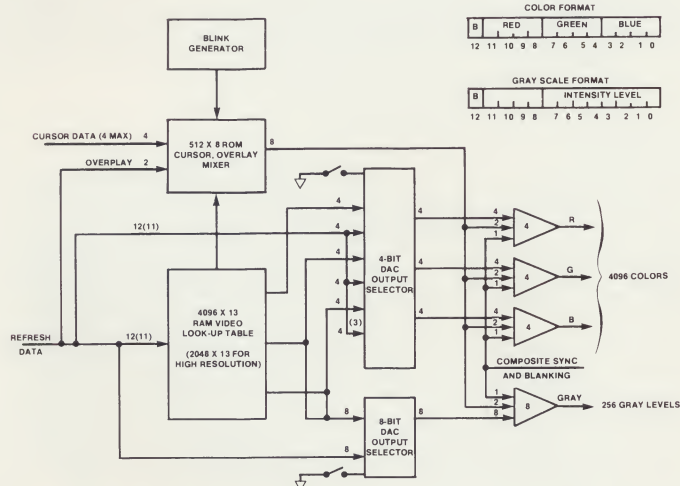
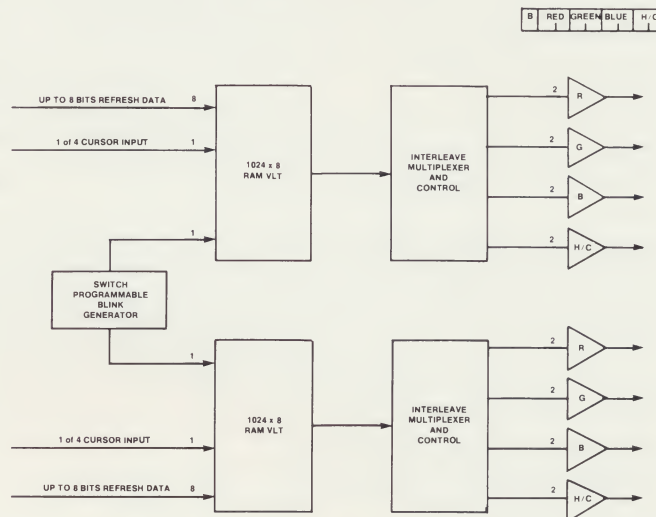**FIGURE 2—RM-9400 TYPE I VIDEO GENERATOR FUNCTIONAL BLOCK DIAGRAM**

B. The Type II Video Generator (RM-9400-V2) is designed for general image processing and extremely sophisticated graphics applications. The RM-9400-V2 drives a single 8-bit (256-level) and three 4-bit (16-level) outputs to a single monochrome and/or RGB color display through a programmable video lookup table (VLT). Display resolution and refresh frequency dictate effective VLT length. The VLT is 2048 x 13 bits in the RM-9400/6X, 7X, 8X and 9X Display Generators. In all other systems, the VLT is 4096 x 13 bits.

The RM-9400-V2 provides hardware blink and mixes up to four independent cursors and overlays with any of the four video outputs. The VLT allows the user to program any of 256 output intensities or 4096 colors for any of 2048 (or 4096) pixel values. For applications that require the RM-9400-V2 to process fewer than 11 (or 12) bits of image data, the VLT is uniquely partitioned into smaller tables that can be selected by a single instruction. By combining three RM-9400-V2 video generators, one for each primary color, the user can display more than 16 million colors.

FIGURE 3—RM-9400 TYPE II VIDEO GENERATOR FUNCTIONAL BLOCK DIAGRAM

C. The Type VIII Video Generator (RM-9400-V8) is designed for sophisticated graphics applications. The RM-9400-V8 Video Generator drives eight 2-bit (4-level) video outputs to eight monochrome or two RGB color displays through two 1024 x 8-bit programmable VLT's. Each VLT processes up to eight refresh memory planes, one cursor, and blink frequency. Cursor and overlay mixing is performed by the VLT. The VLT allows the user to program any of the four output intensities, per primary color, e.g., eight independent refresh planes might be translated to any of 64 colors, with certain bit planes being given priority (or treated as overlays).

FIGURE 4—RM-9400 TYPE VIII VIDEO GENERATOR FUNCTIONAL BLOCK DIAGRAM

Programming

The RM-9400 instruction set is upward compatible from the Ramtek RM-9000 and RM-9050 instruction sets. While the RM-9400 offers increased resolution, performance and local intelligence, these new features have been incorporated by extending the original instruction sets. Thus, existing RM-9000 and RM-9050 system and application software can be converted to the RM-9400 with little or no modification. For new users, it should be noted that Ramtek offers a FORTRAN library, interface and device handlers for several popular minicomputers and operating systems.

The RM-9400 decodes and processes a high-level, binary formatted instruction set. Instructions are typically transmitted and received via a high-speed 16-bit parallel interface. The instructions are highly compact, yet extremely flexible. Each instruction consists of one or more 16-bit words. The received instructions may be executed immediately or stored as subpictures (display lists) in user memory for deferred execution. Sophisticated users may also down-line load Display Processor control code that might augment or redefine the RM-9400 instruction set, and/or implement local application-oriented functions.

Whether executed in real time or on a deferred basis, the RM-9400 instructions address the screen in terms of virtual endpoints. Picture enlargement is accomplished by coordinate transformation, but without affecting line thickness, texture or character size (which is independently variable). Clipping is performed to arbitrary rectangular boundaries. The virtual picture is projected into the refresh memory by re-executing the command list. The refresh memory is then projected onto the tube face by pan and zoom hardware, but under frame-synchronized software control. Thus, animation and film loop capabilities are provided. Finally, optional RM-9400 hardware performs pseudocolor or gray scale translation of stored pictures, again under software control.

Like subpictures, special symbol fonts may also be down-line loaded, then called as ASCII characters. Maximum font resolution is 16 x 20 elements. Characters may be randomly positioned on the face of the display. Character, raster and image data are independently scaled and windowed. Powerful graphing functions include vector, conic, filled polygons, plot and bar chart. Line attributes include line color/intensity and texture.

The following information briefly summarizes the programmable features of the RM-9400 Display Generator:

• Primitives
Erase, point, solid rectangle, vector, conic, solid polygon (fill), text and special symbol, raster, plot, bar chart, and continuous tone image (8 or 16 bits/pixel).

• Attributes
Foreground and background color and/or intensity, line texture, character size and orientation, window, reverse background, and additive write.

• Fonts
Standard font contains 128 symbols defined within a 7 x 9 element dot matrix. Up to fifteen additional fonts may be down-line loaded. Maximum font resolution is 16 x 20 elements; however, symbols may be enlarged by pixel replication.

• Coordinate Transformations
Translate, 2D rotate and scale.

• Addressing Modes
Absolute, relative and indexed. Separate instructions also provide transfer of cursor coordinates to pen position (COP) or index registers.

• Picture Resolution
32K x 32K virtual picture.

• Screen Resolution
256/512/1024 lines x 512/640/1024/1280 elements (see Table 1).

• Video Functions
Pan, zoom (in integer steps between 1:1 and 16:1 independently in X and Y), blink and color/intensity translation.

• Subpictures
Stored locally as graphic subroutines in 4 to 16K byte memory segments.

• Declutter
Adds detail (resolution) as the picture is enlarged, and subtracts detail as the picture is reduced.

• Entity Detect
Identifies procedures and/or instructions that attempt to draw primitives within a prescribed rectangular window (target).

• Clip Window
Constrains pictures to arbitrary viewports on the display surface.

• Format Window
Begins a new line or page when the current line or page is filled to capacity while writing font, raster or image data.

• Rotation
Graphics rotation in one degree increments via coordinate transformation. Font, raster and image data may be rotated in 90 degree increments.

• Scroll
Up, down, left and right within arbitrary rectangular limits.

• Readback
Provides for retrieval of user memory, refresh memory, video lookup table(s), cursor coordinates, keystroke input, and status information.

• Interrupts
Peripheral activity and illegal instruction.

• Delays
Program execution may be synchronized to vertical interval and refresh of specific raster lines.

Physical Specifications

• Mechanical
Two separate rack mount chassis are available. The first chassis (RM-9400/X0) provides 16 card slots and measures 14.0 inches high, 19.0 inches wide, and 28.0 inches deep. The second chassis (RM-9400/X1.) provides 25 card slots and measures 31.25 inches high, 19.0 inches wide, and 25.0 inches deep. The printed circuit boards mount horizontally, and measure 14.5 x 16.2 inches. Access to the logic boards is provided by a hinged front door.

• Electrical
Line voltage may vary between 100 and 130 VAC or 190 and 250 VAC and between 47 and 66 Hz. Maximum power consumption is 1425 and 2325 watts for the small and large chassis, respectively.

• Environmental
Operating temperatures may vary between 0 and 50 degrees centigrade, with 10 to 95 per cent relative humidity, non-condensing.

Specifications are subject to change without notice.

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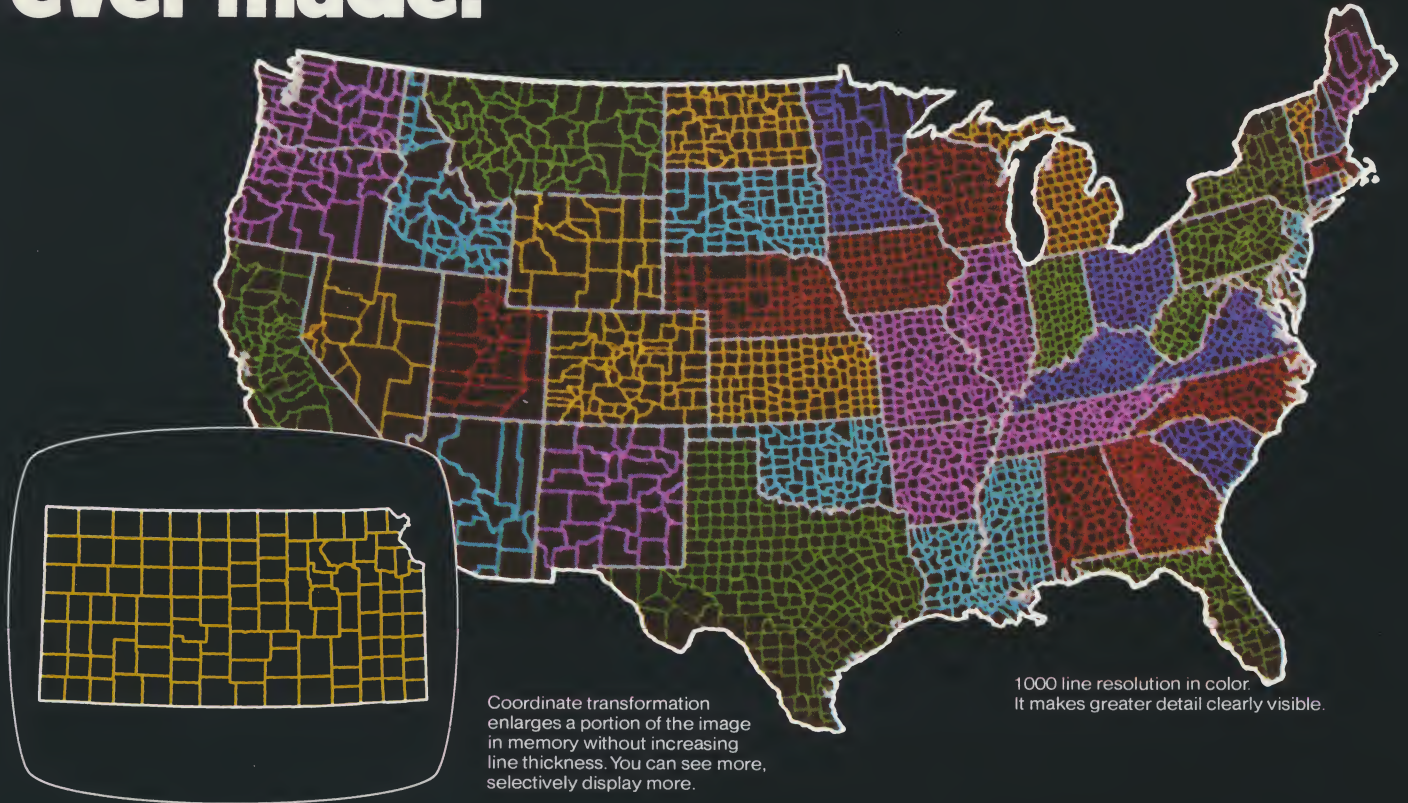
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Ramtek introduces the most powerful raster graphics and imaging display system ever made.

Coordinate transformation enlarges a portion of the image in memory without increasing line thickness. You can see more, selectively display more.

1000 line resolution in color. It makes greater detail clearly visible.

Here's the Ramtek 9400. Finally, a display that combines raster color, 1000 line resolution, coordinate transformation, high-speed graphics and more—all in one package.

It's colorful. More than 16 million color possibilities thanks to raster scan technology. Or, choose black and white or gray scale.

It's fast. Vector writing speeds are greater than 16,000 vectors a second with 50 pixel average vector lengths.

It's sharp. At the top of the line you can display—in color—1024 scan lines of 1280 elements.
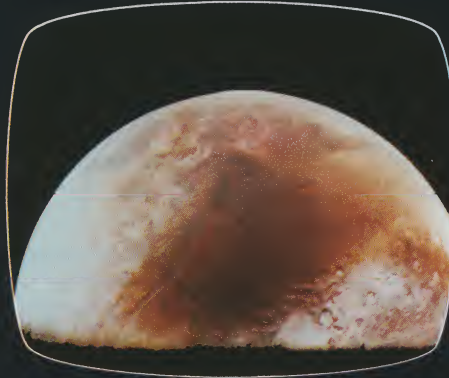
It's powerful. Local spatial transformations include translate, rotate, scale, pan and zoom. You can store and deal with pictures that are much larger or more detailed than can be displayed at one time. De-cluttering allows greater detail to be displayed as the picture is enlarged or less as it's reduced.

It's convenient. Subpictures and special symbols may be down loaded and stored in user memory. Pictures from display lists can be clipped to arbitrary viewports on the display surface.

It's interactive. Subpictures can be called by keyboard function keys. The entity detection feature identifies graphic procedures and instructions that draw objects pointed out by the operator. Interactive controls include a general purpose keyboard, trackball, joystick, light pen and tablet.

It's more than one. The 9400 system is seven different models offering resolution from 256 x 640 to 1024 x 1280. All with the same powerful range of capabilities for command and control, process control, mapping, computer aided design, remote sensing—or any application requiring the ultimate in graphics and imaging potential.

It's more than ever. The sophisticated graphics user no longer has to settle for monochrome or limited color. Now, you can have high density, flicker-free *color* and high speed performance. Ramtek put it all together in the 9400.

It's available now. For more information call your nearest Ramtek office. Or, write: Ramtek, 585 N. Mary Avenue, Sunnyvale, CA 94086.

Ramtek
Our experience shows.

REGIONAL OFFICES: Sunnyvale, CA (408) 735-8400; Newport Beach, CA (714) 979-5351; Dallas, TX (214) 422-2200; Maitland, FL (305) 645-0780; Huntsville, AL (205) 837-7000; Chicago, IL (312) 956-8265; Cleveland, OH (216) 464-4053; Washington, D.C. (301) 656-0350; Metropolitan N.Y. (201) 238-2090; Boston, MA (617) 862-7720; West Germany (0611) 771070.

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32K x 32K virtual picture.

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RM-9400/7X	512	1280	4:3	15:8	50/60Hz Repeat Field
RM-9400/8X	1024	1024	1:1(1)	1:1	25/30Hz Interlaced
RM-9400/9X	1024	1280	4:3	15:16(2)	25/30Hz Interlaced

Notes: (1) Active raster is centered within 4:3 CRT aspect ratio.
(2) Square pixel aspect ratio is within range of monitor adjustment.

Physical Specifications

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